

What we claim is:

1. An electric public transit system, comprising  
an electric driven bus equipped with a cassette battery set and a bus-mounted control system;  
a charge station placed in a predetermined place for charging cassette battery sets; and  
a loading and unloading apparatus; wherein  
when the bus needs change the cassette battery set, the loading and unloading apparatus unloads the cassette battery set from the bus and loads a charged cassette battery set into the bus;  
the charge station and the loading and unloading apparatus are equipped with their control systems respectively;  
the loading and unloading control system, the bus-mounted control system and the charge control system are able to intercommunicate;  
whereby when the loading and unloading control system receives a signal sent from the bus-mounted control system of the bus that the bus will return to the charge station, the loading and unloading apparatus moves to a predetermined position corresponding to the bus at the charge station and waits; and  
when the bus arrives at the predetermined position, the loading and unloading apparatus exchanges cassette battery sets, whereby the bus is able to operate on line continuously.
2. The electric public transit system of claim 1, wherein  
the bus-mounted control system includes at least one PLC programmable logic controller, after the loading and unloading apparatus completes exchanging cassette battery sets, the bus-mounted control system controls to lock the cassette battery set and complete whole electrical connection within the bus;  
the bus has a special chassis equipped with a hanger frame for holding the cassette battery set, the hanger frame is equipped with rollers capable of engaging with the cassette battery set and electrical connection means for implementing electrical connection with the cassette battery set;  
the hanger frame is further equipped with at least two locking means;  
each of the locking means includes a motor, a reduction gear, and a screw rod press means driven by the reduction gear; and

whereby when the cassette battery set is inserted into a cavity of the hanger frame on the special chassis and positioned, the locking means are controlled by the bus-mounted control system to lock the cassette battery set on the hanger frame so as to ensure security of the bus during operating.

3. The electric public transit system of claim 1, wherein

the bus-mounted control system includes at least one PLC programmable logic controller, the bus has a frame of a truss type structure, the truss type structure is formed with a whole skeleton, and a whole integral body is formed, and

a hanger frame is positioned on a chassis of the frame for containing the cassette battery set, and equipped on both sides of the frame of the hanger frame with rollers, locking means, positioning means, and joint means for engaging with the loading and unloading apparatus.

4. The electric public transit system of any one of claims 1 to 3, wherein

the bus is further equipped with an auxiliary start means;

the auxiliary start means includes capacitors and an auxiliary motor, high power ratio charging and discharging characteristic of the capacitors is utilized for storing energy produced during electric braking for a use by the auxiliary motor, and

the bus-mounted control system determines whether a current speed of the bus is zero or not, if the speed is accelerating from zero, the auxiliary motor is started to aid a main motor of the bus for starting the bus with a reduced starting current.

5. The electric public transit system of any one of claims 1 to 3, wherein

the bus is further equipped with a two-grade braking means;

whereby when a driver steps on a brake pedal lightly, a main motor of the bus is changed to a generator for changing inertia kinetic energy of the bus into electrical energy, which is charged into a bus-mounted capacitor for storing by a charging controller in an electric braking system; and

when the driver steps on the brake pedal deeper, a pneumatic brake system is started for braking the bus, the pneumatic brake system includes a motor, an air pump and a gas container.

6. The electric public transit system of claim 4, wherein

the bus is further equipped with a two-grade braking means;

whereby when a driver steps on a brake pedal lightly, a main motor of the bus is changed

to a generator for changing inertia kinetic energy of the bus into electrical energy, which is charged into a bus-mounted capacitor for storing by a charging controller in an electric braking system; and

when the driver steps on the brake pedal deeper, a pneumatic brake system is started for braking the bus, the pneumatic brake system includes a motor, an air pump and a gas container.

7. The electric public transit system of any one of claims 1 to 3 and 6, wherein the cassette battery set includes a housing for containing battery units, a plurality of groups of battery units connected together by wires within the housing, and sockets placed on the housing;

the plurality of groups of battery units are spaced by partitions, each group of battery units comprises a plurality of battery units, the battery units and groups of battery units are electrically connected by wires to rods of the sockets; and

the housing of the cassette battery set is further equipped with positioning means, locking means and openable covers, the positioning means and locking means are used for positioning and locking the housing on the bus respectively and adopt pin-hole connections, and the openable covers are mounted above openings of cavities of the sockets.

8. The electric public transit system of any one of claims 1-3, 6, wherein the bus changes the cassette battery set when the discharge depth of the cassette battery set is about 60% to 80%.

9. The electric public transit system of claim 8, wherein the bus changes the cassette battery set when the discharge depth of the cassette battery set is up to about 70%.

10. The electric public transit system of claim 1, wherein the charge station further includes chargers, a charging shelf for containing cassette battery sets, and a power grid auto-trace apparatus for searching electrical consumption valleys;

the chargers comprises a high-tension charger and a low-tension charger;  
the charge control system is a programmable logic controller; and  
the programmable logic controller, based on voltage data of power grid for each period scanned by the power grid auto-trace apparatus at all period of time, controls the chargers to

charge cassette battery set during electrical consumption valleys of power grid and to keep float charging to cassette battery set for the rest time.

11. The electric public transit system of any one of claims 2, 3, 6 and 9, wherein the charge station further includes chargers, a charging shelf for containing cassette battery sets, and a power grid auto-trace apparatus for searching electrical consumption valleys;

the chargers comprises a high-tension charger and a low-tension charger;

the charge control system is a programmable logic controller; and

the programmable logic controller, based on voltage data of power grid for each period scanned by the power grid auto-trace apparatus at all period of time, controls the chargers to charge cassette battery set during electrical consumption valleys of power grid and to keep float charging to cassette battery set for the rest time.

12. The electric public transit system of claim 10, wherein

the charging shelf is further equipped with a sampling means, capacity displayer for showing capacity of the cassette battery set, and a temperature measure and control means;

the temperature measure and control means can adjust temperature within the charging shelf based on predetermined battery category and model; and

the charging shelf further includes a plurality of layers of cavities for containing cassette battery sets, the charging shelf is further equipped with electrical connection means for electrically connecting with cassette battery sets, guiding wheel means, and joint means for jointing with the loading and unloading apparatus.

13. The electric public transit system of claim 10 or 12, wherein

the charge station further comprises a plurality of charging shelves and a plurality of loading and unloading apparatus for implementing loading, unloading and charging cassette battery sets for a plurality of buses simultaneously.

14. The electric public transit system of claim 2 or 12, wherein

the electrical connection means is a crocodile clamp contact means, which includes a camshaft clamp means for smoothly moving a cassette battery set into or out of a cavity for containing the cassette battery set in the bus, when the cassette battery set is positioned and locked by the locking means, the camshaft clamp means operates to implement electrical connection.

15. The electric public transit system of claim 14, wherein

the crocodile clamp contact means includes a stator, an actor and a support shaft made of conductive metal material, a camshaft with cams made of insulating material, and a driving motor;

after the cassette battery set is inserted into the cavity for the cassette battery set in the bus and accurately positioned, the bus-mounted control system sends a signal to control the camshaft driven by the driving motor to make the stator and the actor of the crocodile clamp contact means tightly clamp a rod; and

when the cassette battery set needs change, the bus-mounted control system sends instruction to relax the crocodile clamp contact means, and then the actor is open for implementing no resistant plug-in and out of a high-tension contact section and ensuring smoothly inserting into or pulling out the cassette battery set;

16. The electric public transit system of claim 15, wherein

the crocodile clamp contact means includes a high-tension contact section and a low-tension contact section;

the high-tension contact section is, after connected, for providing a high-tension power to a main motor of the bus; and

the low-tension contact section is, after connected, for providing a low-tension power to other electric appliances needing low-tension power in the bus.

17. The electric public transit system of any one of claims 1-3, 10, and 15, wherein

the loading and unloading control system includes at least one PLC programmable logic controller for controlling the loading and unloading apparatus to perform exchanging of cassette battery sets; and

the loading and unloading apparatus is of a mechanical arm structure, including a moving platform, a tray, a lift means, moving tracks of the moving platform, and wheels; the lift means can lift the tray in a direction vertical to a top plane of the moving platform, and the track wheels are mounted on the bottom of the moving platform.

18. The electric public transit system of claim 17, wherein

the mechanical arms further includes a rotating platform, a rotating mechanism and a driving means for driving the rotating platform; and

the rotating platform is placed on the moving platform, and can rotate to 90 degree or 180

degree on the moving platform so as to insert a charged cassette battery set into the bus, and/or deliver a used or broken cassette battery set to the charging shelf or a repair platform in the charge station.

19. The electric public transit system of claim 17, wherein
  - the lift means further includes a lifting system comprising two sets of lifting arms and driving means;
  - the mechanical arms and the charging shelf both are placed under ground of the charge station;
  - while the bus is returning the charge station, one set of the lifting arms takes out a charged cassette battery set corresponding to the bus in advance, and moves to the predetermined position corresponding to the bus and waits;
  - when the bus stops at the predetermined position, the other set of the lifting arms takes the used cassette battery set from the bus and moves down to a layer on the charging shelf corresponding to the cassette battery set, and the one set of the lifting arms with the charged cassette battery set in arms moves close to the cavity for cassette battery set in the bus and push the charged cassette battery set in; and
  - the other set of the lifting arms with the used cassette battery set puts the used cassette battery set into the corresponding layer.

20. The electric public transit system of claim 18 or 19, wherein
  - the mechanical arms further include sensors for detecting positions of the bus and the charged cassette battery sets to be taken from the charging shelf; and
  - sensors are placed on different positions on the mechanical arms in a lifting vertical direction and the charging shelf correspondingly, in order to position freely the tray to any layer of the charging shelf in the vertical direction.

21. The electric public transit system of any one of claims 1-3, 9, 10, 15, 18 and 19, wherein
  - the electric public transit system further includes a control center; and
  - the control center comprises a PC and/or at least one PLC programmable logic controller; the control center is placed in the charge station and can intercommunicate with the charge control system.

22. The electric public transit system of claim 21, wherein

the charge control system and the control center can share same programmable logic controller.

23. The electric public transit system of one of claims 1-3, 9, 15, 18, 19 and 22, wherein the electric public transit system further includes a dispatch and rescue service system; the dispatch and rescue service system has at least one urgent service vehicle; the dispatch and rescue service vehicle is equipped with a bus-mounted battery carrier and a battery passage;

the battery carrier has a spare charged cassette battery set;

the battery passage has a cavity, joint arms and driving means, the battery passage is used for taking a broken cassette battery set from and inserting a spare cassette battery set into the bus; and

the joint arms and the driving means are used for jointing the battery passage with an opposite position for the housing of the cassette battery set on the chassis of the bus.

24. The electric public transit system of one of claims 1-3, 9, 10, 15, 19 and 22, wherein the electric public transit system further includes a urgent loading and unloading apparatus comprising a scissor lifting mechanism, a hydraulic driving means, a tray for cassette battery set, main wheels driven by a power means, auxiliary wheels steered by manual, and a handle;

the tray for cassette battery set is further equipped with a joint means and a moving means; and

the moving means is a fork driven by a chain, which can move the cassette battery set from a cavity for cassette battery set in the bus to the tray of the mechanical arms, or deliver the cassette battery set into the cavity for cassette battery set in the bus.

25. A method for operating an electric public transit system, comprising  
an electric driven bus equipped with a cassette battery set and a bus-mounted control system;

a charge station placed in a predetermined place for charging cassette battery sets; and  
a loading and unloading apparatus; wherein

when the bus needs change the cassette battery set, the loading and unloading apparatus unloads the cassette battery set from the bus and loads a charged cassette battery set into the bus;

the charge station and the loading and unloading apparatus are equipped with their own control systems respectively;

the loading and unloading control system, the bus-mounted control system and the charge control system are able to intercommunicate;

whereby when the loading and unloading control system receives a signal sent from the bus-mounted control system of the bus that will return to the charge station, the loading and unloading apparatus moves to a predetermined position corresponding to the bus at the charge station and waits; and

when the bus arrives at the predetermined position, the loading and unloading apparatus exchanges cassette battery sets, whereby the bus is able to operate on line continuously.

26. The method of claim 25, wherein

when the bus-mounted control system detects a battery unit or a group of battery units in the cassette battery set being unable to work, the bus-mounted control system sends a warning signal to the driver of the bus;

if the rest of battery units in the cassette battery set has enough capacity to support the bus to return the charge station, the bus is driven back to the charge station, otherwise an rescue signal is sent out;

after receiving the returning signal from the bus, the charger station sends instruction to wait for exchanging the failed cassette battery set; and

the loading and unloading apparatus moves to the front of the charging shelf having a charged cassette battery set to be taken and waits for the bus, and a repair procedure of the repair system for cassette battery set is started, then the failed cassette battery set taken by the loading and unloading apparatus is delivered to the repair stage at the charger station for testing and repairing.

27. A method for charging the cassette battery sets of the electric transit system of claim 1, comprising

turning on the power of a charger;

reading data of the cassette battery set by the charge control system;

determining whether a power grid used is in valleys or not by a power grid auto-trace apparatus,

if yes, starting a full charge program in the charger controlled by the charge control

system, and charging the cassette battery set with full current until the cassette battery set is fully charged,

if no, starting a float charge program in the charger controlled by the charge control system, and charging the cassette battery set with float current;

charging the cassette battery set with float current when the cassette battery set is determined having been fully charged by the charge control system, whereby the cassette battery set is being charged at least with float current all the time except being used in the bus; and

reading charging data of the cassette battery set and sending to the charge control system.